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Final Frontier at Hanford: Tackling the Central Plateau

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management
Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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The large land area in the center of the vast Department of Energy (DOE) Hanford Site in southeast Washington State is known as "the plateau" – aptly named because its surface elevations are 250-300 feet above the groundwater table. By contrast, areas on the 585-square mile Site that border the Columbia River sit just 30-80 feet above the water table.

The Central Plateau, which covers an ellipse of approximately 70 square miles, contains Hanford's radiochemical reprocessing areas – the 200 East and 200 West Areas – and includes the most highly radioactive waste and contaminated facilities on the Site. Five "canyons" where chemical processes were used to separate out plutonium (Pu), 884 identified soil waste sites (including approximately 50 miles of solid waste burial trenches), more than 900 structures, and all of Hanford's liquid waste storage tanks reside in the Central Plateau. (Notes: Canyons is a nickname given by Hanford workers to the chemical reprocessing facilities. The 177, underground waste tanks at Hanford comprise a separate work scope and are not under Fluor's management.)

Fluor Hanford, a DOE prime cleanup contractor at the Site for the past 12 years, has moved aggressively to investigate Central Plateau waste sites in the last few years, digging more than 500 boreholes, test pits, direct soil "pushes" or drive points; logging geophysical data sets; and performing electrical-resistivity scans (a non-intrusive technique that maps patterns of sub-surface soil conductivity). The goal is to identify areas of contamination areas in soil and solid waste sites, so that cost-effective and appropriate decisions on remediation can be made.

In 2007, Fluor developed a new work plan for DOE that added 238 soil waste-site characterization activities in the Central Plateau during fiscal years (FYs) 2007-2010. This number represents a 50 percent increase over similar work previously done in central Hanford. Work Plans are among the required steps in the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) cleanup process. The CERCLA process is used to oversee the investigation, decision-making and remediation of "past practices" (historical) sites, as opposed to sites in active use.

For the first several years of Hanford's cleanup work, everyone concerned – the Department, contractors, regulatory agencies, stakeholders and Indian nations and tribes – focused efforts on the rivershore. The magnificent Columbia River – eighth largest in the world – flows through and by the Hanford Site for 52 miles. Two million people live downstream from Hanford along the Columbia before it empties into the Pacific Ocean. Further, the part of the river known as the "Hanford Reach" is a prime habitat for salmon, steelhead, sturgeon and other species of fish. In fact, it provides a spawning ground to more salmon than any other stretch of river in the United States outside of Alaska.

For these reasons, protecting the Columbia by cleaning up waste directly along its shoreline was an early priority in Hanford's Federal Facility Agreement and Consent Order (or Tri-Party Agreement) signed in 1989 among the DOE, U.S. Environmental Protection Agency (EPA) and Washington State to govern cleanup. However, Tri-Party Agreement signatories and others concerned with Hanford and the Columbia River, knew that the waste located in, and beneath, the Central Plateau could also pose dangers to the waterway. While the waste in central Hanford might move more slowly, and pose fewer immediate threats, it would have to be dealt with as cleanup progressed.

Beginning: A Comprehensive Plan for the Central Plateau

In 2004, Fluor's Central Plateau Deactivation and Decommissioning (CP D&D) Project jump-started the process of organizing cleanup in the central part of Hanford when it completed the Central Plateau Closure Plan. This document, the first all-encompassing look at central Hanford, organized cleanup work over the next several decades into 22 "closure zones." It identified a zone for each reprocessing canyon, for the Plutonium Finishing Plant (PFP), for waste ponds, tank farms, solid waste burial sites and for other contaminated portions of the 200 Areas. Within the 22 closure zones, approximately 4,000 items were identified as needing to be addressed as part of Site cleanup.

The following year, the CP D&D Project completed, and achieved external agreement on, the first Record of Decision (ROD) delineating the final "end state" of a Hanford canyon. The canyon will be partially demolished and collapsed in place, then capped with an engineered barrier. Since the ROD was signed by the DOE and regulators, the Project has produced the first two drafts of U-Plant's Remedial Action Work Plan, and started initial work that includes engineering studies to reactivate those portions of U-Plant's equipment that will be needed to demolish the facility.

In 2007, the Project generated a Multi-Canyon Project Management Plan that outlined a path for scheduling and preparing several key regulatory decision documents necessary to reaching the end state for Hanford's PUREX (plutonium uranium extraction) Plant, B-Plant, and the REDOX (reduction-oxidation) Facility. The other Hanford canyon, T-Plant, was not included because it is an operating facility with no D&D planned in the near future.

Cleanout of nuclear facilities continued in 2007, when Fluor's CP D&D Project removed a unique collection of large radioactive containers from the World War (WW) II 212-N Storage Facility in central Hanford. With the containers removed, the status of the facility was downgraded from "nuclear" to "radiological," thereby reducing the need for surveillance and saving money in the process. The Project is currently cleaning out another WWII nuclear facility to further reduce costs. In the past four years, Fluor has demolished over 125 aging facilities in the Central Plateau, including three extremely contaminated with plutonium.

Focusing on Soil Waste

Although the massive Hanford canyons and other contaminated facilities are important and challenging, the soil and soil wastes of the Central Plateau may present more complicated puzzles. In the past five years alone, Fluor Hanford has unearthed enough information through accelerated physical and documentary characterization that signatories of the Tri-Party Agreement decided to change milestones to allow more time to gather more information and make better informed decisions.

The revised milestones, known as the M-15 in the Tri-Party Agreement, moved the final dates for completing key waste-site investigations and feasibility studies in the regulatory process from December 2008 to December 2011. The new milestones also carved out three additional operable units (OUs) among Hanford's Central Plateau waste sites, bringing the total number of soil OUs to 25. Operable units are groupings of waste sites or areas of groundwater or soil contamination designated under CERCLA.

Bruce Ford, Fluor's vice president for the Soil and Groundwater Remediation Project (SGRP), explains that "the size of the challenge posed by central Hanford's waste sites is just now being understood. In the past few years, we've uncovered a huge amount of new data. As the CERCLA process progressed and decisions approached for several waste sites, people began to feel that maybe the amount and types of waste in central Hanford were more extensive or more varied than was realized. Stakeholders expressed the desire for more information. The new Tri-Party Agreement milestones allow an extra three years to obtain more complete data to support better remediation decisions." He adds that "it's awfully hard to make decisions that will stand for thousands of years."

Investigation of Soil in Hanford's Major Ponds Intensified

The first soil areas to receive additional characterization as a result of the revised M-15 milestones were the major waste-disposal ponds that once existed at Hanford. In total, the seven major ponds -- grouped into the T, S and U Pond systems in the 200 West Area, and the B Pond and Gable Mountain Pond systems in the 200 East Area -- received approximately 211 billion gallons of slightly contaminated liquid wastes from 200 Areas facilities between 1945 and 1987. That amount is nearly half of the total volume of low-level liquid effluents (440 billion gallons) discharged to soil throughout Hanford's history. The last of Hanford's major ponds were drained, and their surfaces stabilized in a limited manner with clean dirt or gravel, in the late 1980s.

In 2007, Fluor submitted to DOE and began implementing a supplemental characterization plan to gather additional data in the soil of the now-dried ponds. Of the 113 additional "direct-push" samples agreed to in the new M-15 milestones, about 65 percent are being taken in the "large-area" ponds – making the ponds a crucial segment of the supplemental investigations.

Seven large-area ponds are being further investigated. The ponds are part of Hanford's 200-CW-1, 2, 4 and 5 Operable Units (OUs). CW stands for cooling water.

In addition to activities to collect 73 new direct-push samples, Fluor is drilling an extra borehole and collecting three additional test-pit (surface-level) samples at the 216-U-10 pond. More than 200 boreholes, direct pushes, test pits and other investigative techniques have already collected samples from Hanford's large-area ponds.

Contaminants of concern in the soil of the large-area ponds include cesium-137 (Cs-137); strontium-90 (Sr-90); neptunium-237 (Np-237); various isotopes of Pu and uranium (U); americium-241 (Am-241); technetium-99 (Tc-99); europium-154 (Eu-154); hazardous metals including lead and cadmium; cyanide; nitrates; mercury; and other radionuclides and chemicals.

"We want to get on with characterizing these ponds and developing cleanup recommendations sooner rather than later," said Becky Austin, Central Plateau Remediation Director for Fluor Hanford. In addition, she says some of the ponds -- notably Gable Pond and the S Ponds -- lie outside the actual boundaries of the 200 Areas. "By characterizing them well, we give the DOE and the regulatory agencies the data they need to 'shrink the footprint' of zones of contamination in the Central Plateau, and thus save costs by operating long-term waste- management activities in a smaller core zone of Hanford."

Gable Pond (216-A-25 Pond) is the largest site, and received the most effluent of any Hanford disposal unit. Its 71 acres, situated north of the 200 East Area, received over 81 billion gallons of wastewater from the mid-1950s to the late 1980s. B Pond (216-B-3 site), inside the 200 East Area just east of B-Plant, occupied 35 acres and received over 63 billion gallons of effluent discharges beginning in 1945. A complex system of ditches brought wastes to both B Pond and Gable Pond.

U Pond, at 30 acres, received nearly 44 billion gallons of effluent from U-Plant, the Uranium Trioxide Plant, and laboratory and laundry facilities in 200 West Area, as well as some effluents from PFP. One single incident in 1986 discharged nearly 800 gallons of contaminated nitric acid to the pond, raising detectable levels of uranium in nearby groundwater for a year.

The S Ponds complex (216-S-16, 216-S-17, and UR [Unplanned Release] Site 200-W-124) just south of the 200 West Area fence received over 12 billion gallons in discharges, mostly from the REDOX Plant. REDOX was known as "S" Plant in its early days. The S Ponds will receive the most additional characterization, with 36 direct pushes. One overflow area adjacent to the 216-S-17 pond will also be sampled in a phased manner if contamination is found outside the expected pond site boundary. The 216-T-4B Pond near T Plant received more than 11 billion gallons of waste discharges, mostly in Hanford's early years.

Investigations of 200-SW-2 Burial Grounds Massive Job; Uncovers Many Surprises

In perhaps its largest soil waste-characterization project thus far, Fluor's SGRP completed a three-year effort in 2007 when it delivered a Draft Remedial Investigation/Feasibility Study Work Plan for one of Hanford's most extensive soil OUs. The 200-SW-2 operable unit contains 24 radioactive waste burial grounds in the 200 East and West Areas, totaling about 700 acres and containing multiple burial trenches. In all, there are nearly 350 trenches that would stretch approximately 43 miles if laid end-to-end. This OU contains most of the radioactive waste burial grounds in Hanford's Central Plateau, with the exception of specialized burial grounds associated with specific events or activities.

"Our effort is the first real comprehensive look at the majority of 200 Areas solid-waste burials in a decade," says Ford. "The 200-SW-2 Work Plan outlines a path forward for characterizing the burial grounds to ultimately support decisions on how the burial grounds will be remediated. It's going to be a big job."

The 200-SW-2 burial grounds are estimated to hold nearly 600,000 cubic yards of waste, and available historical records show the waste would have included over nine million curies of beta-gamma radioactivity at the time of burial. Beta-gamma radioactivity comprises beta particles and gamma rays generated as radioactive materials "decay" or seek stability. In general, it is considered less hazardous on a per-curie basis than alpha radioactivity, and is more likely to be found in low-level waste than in highly radioactive solid waste containing "transuranic" materials.

To determine the history and understand the contents of the 200-SW-2 burial grounds, experts gathered and examined over 147,000 historical records. Many of the records had seemingly contradictory information, as well as gaps in data, particularly in the older files.

One complicating factor stems from the fact that some waste burials took place before 1970 and some occurred after 1970. That year, a joint task force of all Hanford contractors and the Atomic Energy Commission (AEC – a predecessor agency to the DOE) changed Hanford's burial policies significantly. Aware of the burgeoning environmental consciousness in the United States (the National Environmental Policy Act became law that year), the AEC and contractor team decreed that future solid waste burials would be segregated by type and labeled. Further, logbooks would be kept strictly rather than sporadically, and specific containers were designated and approved for certain waste types.

Fluor scientists estimate that about one-third of the waste in the 200-SW-2 trenches was disposed before 1970, making its traceability difficult. Nevertheless, records indicate that a wide variety of items was buried, including two 1951, International Harvester pickup trucks buried in 1961 and in 1973. Other unusual "finds" have been animal carcasses from the Hanford radiobiology farm, an experimental station at the University of California at Davis, and other locations. About 10 railroad cars were buried, plus additional parts of about 40 other rail cars such as planking, wheels and undercarriage. Mobile offices (trailers for changing from radioactively contaminated work clothing to everyday clothes) that became contaminated were crushed and buried, as was some fallout sample waste from nuclear bomb tests at the Nevada Test Site (Operation Plowshare). One extraordinary item is a 17-foot boat, described in late 1960s burial records as having a 60-horsepower outboard motor and requiring nearly 14 cubic yards of space to bury.

Highly contaminated equipment from the REDOX and PUREX Plants and other Hanford facilities were buried in 200-SW-2 trenches in the 1950s and 1960s. Both PUREX and REDOX underwent repeated, large "capacity expansions" during those years, and many of their internal vessels were replaced with larger vessels to increase plutonium production.

Many other burial records from those years simply note "facility modification debris," as PFP, Hanford laboratories and other facilities expanded to meet Cold War demands. In the 1980s, debris from the decommissioning of C-Plant, an experimental radiochemical plant also known as the Strontium Semi-Works in the 200 East Area, was buried in one of the unlined 200-SW-2 trenches.

Hanford event records acknowledged that burial grounds sometimes flooded, due to either natural events or breached ditches or waste water lines. In other cases, contamination was spread when fires occurred in the burial grounds or when boxes of material collapsed while being dragged into trenches.

Fluor found helpful information about the sizes, shapes and construction of burial containers, which ranged from cloth or plastic wrap to cardboard, concrete, wood and metal boxes and drums. Also, a few unusual containers such as empty tanks or engineered casks were buried, as were several containers called "caissons." In the 200 Areas, caissons were engineered, concrete and metal cylinders, typically eight to ten feet wide and up to 15 feet high, and were buried as deep as 25-feet. However, some concrete and metal "caissons" are described in records as being taller and more narrow. Descriptions of waste containers can sometimes help understand what might be inside.

In addition to documentary research, Fluor has conducted months of non-intrusive physical characterization of the 200-SW-2 burial grounds. SGRP workers performed surface-radiation surveys, passive organic-vapor sampling, and geophysical investigations using magnetometers and ground penetrating radar (GPR).

GPR readings confirmed definitively that trench coordinates on some maps and drawings are inaccurate. In some cases, trenches are angled slightly off of neat north-south, or east-west coordinates. SGRP team readings did detect large objects of approximately correct sizes at the locations where records indicate that the two trucks are buried, some of the rail cars, and some of the large caissons.

"What we have is a huge puzzle," says Austin. "We have the challenges associated with records, heterogeneous waste streams, and a huge physical area. However, the ultimate goal is to develop good and timely information to provide to the Tri-Parties so they can make the best decisions as to how to remediate these sites."

Inactive Buried Pipelines and Appurtenances Constitute Another Big Challenge

Another major draft work plan submitted by Fluor's SGRP in 2007 addressed more than 100 miles of inactive, contaminated underground piping in central Hanford. The phased plan also outlined the work needed to sample and evaluate the "appurtenances" associated with the pipelines – structures such as diversion boxes, catch tanks, valve pits and related infrastructure that were part of the network that transported liquid wastes from separations facilities to waste tanks or soil waste sites.

Together, these pipelines and appurtenances make up Operable Unit 200-IS-1 (IS stands for infrastructure). Pipes or lines used for water, gas, utilities, and sanitary sewers, are not included in the 200-IS-1 OU, nor are above-ground or active waste lines. Comments on the draft work plan are currently being resolved.

200-IS-1 investigations include inactive process pipes or lines associated with Hanford's single-shell tank farms, as well as those associated with other facilities. To develop sampling objectives and other parts of the plan, Fluor Hanford worked with a joint team comprising representatives from DOE, Tanks Farms' operating contractor CH2MHill Hanford Group (CHG), and the Washington State Department of Ecology (Ecology). Since 2000, thousands of historical records have been examined, and data pertinent to pipes that has been gathered by other Site endeavors has been integrated.

According to Austin, the effort to discover the locations, process streams, conditions and characteristics of all of the piping has been "the most difficult part. There is so much we didn't know that a very large mapping process was needed. When we discovered a line, we mapped it and put it into a 'bin' or large category based on contaminants of concern and historical uses."

Because there is uncertainty about the waste pipelines, Fluor follows an adaptable, graded approach to data gathering and sampling. This practice allows the flexibility to modify techniques to actual site conditions, as the job of finding and sampling Hanford's inactive process piping is just too big to allow prescriptive, pre-determined methods.

During 2008, hundreds of physical samples are being collected, focused mainly at places where leaks are known or believed to have occurred. In addition, some random sampling is being done. Ultimately, the data gathered from the samples will be evaluated to determine the next phase of sampling needed.

Although most the pipes in the 200-IS-1 OU are single-walled, they were built with a variety of materials including vitrified clay, stainless steel, corrugated steel, carbon-steel, cast-iron, and fiberglass-reinforced epoxy or resin. The material selected for the pipes was based on anticipated uses and availability.

By 1956, all of Hanford's five processing canyons had been built, as well as 11 tank farms containing 145 underground high-level waste tanks. Most of the pipelines in the 200-IS-1 OU were built during this extremely busy time, and most were direct-buried in the ground without additional encasements. Also, multiple modifications and new missions sometimes brought wastes into pipes that had not been anticipated when the pipes were installed.

In addition, pipes and appurtenances associated with C-Plant and with the 200-West Area Hexone Storage and Treatment Facility (HSTF) are included in the 200-IS-1 OU. Development tests with radioactive materials for the PUREX and REDOX processes were conducted in C-Plant. The HTSF stored hexone (methyl isobutyl ketone) solvent during the REDOX operating years from 1951-67, that had been used and became radioactive in the plant.

"The 200-IS-1 OU poses some of the most variegated, puzzling and immense challenges on the Hanford Site," says Ford. "In working on this OU, we're essentially discovering some parts of the legacy of chemical processing at Hanford for the first time. There are lots of different issues and requirements that have to be pieced together to come to collaborative agreement among the interested parties to determine what we have and how best to remediate it. In the end, we're all working together to achieve a good, safe environment."

Treatability Test Underway in Portion of BC Cribs and Trenches

In another important thrust into central Hanford soils, Fluor Hanford's SGRP completed a major plan in 2007 and is now digging into test remediation activities in the contaminated area known as the BC Cribs and Trenches area. Crib is an historical Hanford term for an unlined, engineered, liquid-waste disposal site in the soil.

The BC Cribs and Trenches include six cribs and 20 trenches covering about 35 acres. The area, south of and outside of the 200 East Area, is called the 200-BC-1 OU.

Most of the waste in the 200-BC-1 OU results from a special radiochemical separations project that took place at U Plant during 1952-58. The Metal Recovery Mission pumped waste from high-level waste tanks into U Plant, and then chemically separated the uranium and fission products. The earliest chemical separations plants at Hanford – T Plant and B Plant – could capture only the plutonium, and not the uranium in dissolved spent fuel.

Historical records indicate that about 30 million gallons of liquid wastes from the Metal Recovery Mission were disposed to many (but not all) of the BC Cribs and Trenches. In 1965, cooling water from an accident at Hanford's experimental Plutonium Recycle Test Reactor (PRTR) was disposed to a few additional trenches in the BC Cribs area.

High concentrations of Cs-137 and Sr-90 in near-surface soils are the focus of current investigations. However, approximately 400 curies of Tc-99, representing the largest inventory of this radionuclide known to be at the Hanford Site, have been discovered in to the BC Cribs and Trenches.

Tc-99, a beta-emitting radionuclide with a half-life of 212,000 years, is mobile and travels through the groundwater almost as fast as water itself. Sampling data collected thus far indicates that it settled in the deep vadose zone (area between the soil surface and the groundwater) below the BC Cribs.

Fluor's treatability test plan for the BC Cribs and Trenches was written after extensive discussions with the DOE and EPA, and covers activities for FYs 2007-2009. In Phase I, Fluor is drilling three dozen shallow test holes in one 500-foot trench known as 216-B-26, and collecting geophysical logging data from them. Workers will assess Cs-137 levels in the data, as this radionuclide contributes most of the dose to humans and animals that might contact the waste.

In Phase II, roughly the top 15-foot soil layer of the 216-B-26 Trench will be excavated. Phase III, planned for FY 2009, will excavate the 216-B-14 Crib. The crib bottom, about 12-feet down, is presumed to have the highest concentrations of Cs-137. Unlike trenches, early Hanford cribs were constructed with built-up structural components like concrete blocks and steel plates. From this excavation, SGRP personnel hope to understand the potential for subsidence in the crib structure itself, as well as further refine techniques and costs of this type of remediation.

Phase IV of the treatability test plan, also slated for FY 2009, will excavate the near-surface (15-foot depth) contamination of the 216-B-53A Trench. This facility, only 60-feet long, received liquid wastes from the PRTR accident in 1965. Excavation of this trench is expected to yield information about the disposition and behavior of the PRTR wastes in soils.

Additional work being performed in the BC Cribs and Trenches includes drilling five deep boreholes that penetrate into areas in which electrical resistivity characterization was performed during 2004-05. Soil samples will be collected from the boreholes to confirm the permeation of contaminants and establish correlations between concentrations of soil contamination, soil properties, and electrical-resistivity characterization data. Fluor Hanford is also revising a plan to conduct a "deep vadose zone treatability test" to investigate potential methods to fix U and Tc-99 contamination in soils deep below the BC Cribs and Trenches. If successful, the test may point the ways to remediation methods that do not require physically removing the soil.

Integration Between Soil and Groundwater Investigations Brings Added Benefits

Recognizing that studying contaminants that have already reached groundwater can yield valuable information about waste still in the vadose zone and vice versa, Fluor has also implemented synergistic planning, research, regulatory documentation and fieldwork between soil and groundwater OUs. In the 200 West Area, Fluor Hanford took this concept to full fruition in 2006, when it fully integrated the 200-ZP-1 (groundwater) and 200-PW-1/3/6 (soil) OUs. ZP indicates that waste came from Hanford's PFP (known as "Z" Plant), while PW stands for process waste.

Reaching out to other contractors and experts, Fluor added participants from CHG, the Pacific Northwest National Laboratory (PNNL), DOE, URS Corporation, and several smaller businesses. Core team members met regularly with the EPA. According to Ford, the integrated approach being used in joining the ZP-1 and PW-1/3/6 OUs will not be the last. "We believe that integration is the wave of the future," he says.

The 200-ZP-1 OU deals with a huge volume of groundwater contaminated with carbon tetrachloride, Tc-99, nitrates and other constituents beneath the 200 West Area. The 200-PW-1/3/6 OUs deal with soil contaminated primarily with the same organic-rich, radioactive materials in both the 200 West and 200 East Areas. (The carbon tetrachloride in the 200 West Area provides a common link.)

The carbon tetrachloride contamination stems mainly from historical operations in the PFP complex where plutonium-bearing scraps were dissolved in corrosive chemicals to recover the plutonium. Operations to recover plutonium from waste and scraps used tributyl phosphate diluted with carbon tetrachloride. Liquid waste containing carbon tetrachloride was discharged to the trenches and cribs from 1955 to 1973.

Presently, at approximately five square miles, the carbon tetrachloride plume is the largest plume of contaminated groundwater in the 200 West Area, with the exception of nitrate plumes that are pervasive under process areas across the Site. Fluor has examined substrata in this region using multiple soil probes. In 2006, the company investigated the Z-9 crib east of PFP with a slanted borehole – drilled using a technology that had never been applied in a high-radiation environment at Hanford. The unique borehole, slanted at a 32-degree angle, penetrated 140 feet into the soil, with a vertical depth of 123 feet, to sample historical contaminants under the trench.

Drilling equipment could not be set on top of the Z-9 crib because it is "roofed" with a nine-inch thick concrete slab held up by six pillars. Both soil and vapor samples were collected at predetermined intervals along the borehole, and carefully packaged for analysis. A total of 11 soil and nine vapor samples were withdrawn, with the angle and placement of the borehole designed to maximize the number of samples collected directly below the trench floor.

Fluor has been treating the carbon tetrachloride plume in the 200 West Area for many years, and is still expanding efforts. So far, nearly one billion gallons of water have gone through a pump-and-treat system, with more than 24,000 pounds of carbon tetrachloride extracted. Fluor drilled additional wells in 2007, and is planning yet more in 2009, to address the carbon tetrachloride problem. "By 2010," said Mark Byrnes, Fluor's 200-ZP-1 manager, "we will have expanded this pump-and-treat system to cover a larger portion of the aquifer, and when we reach the final-remedy stage, we're looking at pumping at three-to-four times the current rate of about 280 gallons per minute [gpm]."

Working under an Action Memorandum issued in 1992 by the EPA and Washington state, Fluor also extracts carbon tetrachloride as a vapor from targeted soil areas in the 200 West Area. To date, more than 175,000 pounds of the chemical have been extracted.

Ann Shattuck, Fluor's former manager for 200-PW-1/3/6, said "the logic for integrating soil and groundwater work is that by examining a major groundwater plume, along with the soil above and near it, we better understand the relationship between the two, which ultimately leads to making more informed, more comprehensive decisions. We're expecting the biggest and most important impacts from the cooperative team effort on deciding the remedies for these OUs." Byrnes added that "efforts to understand the rate at which the plume is spreading in the groundwater and whether it is being 'recharged' from contaminants in the soil yield the best results when soil and groundwater experts work together."

200-East Area Soil Waste Sites Investigations Correlate with Resistivity and Groundwater Examinations

In 2006, Fluor Hanford began drilling a borehole deep into contaminated soil near the 216-A-4 Crib just south of the PUREX Plant to map and understand a significant portion of the 200-MW-1 OU. MW stands for miscellaneous wastes, and PUREX was known as "A" Plant in its early years so all of its cribs, tanks and ditches have "A" designators. PUREX operated from 1956 until 1972, and then again from 1983-88. The plant was so productive that in just those 21 years, it processed 75 percent of the plutonium ever manufactured at Hanford.

PUREX was served in its early years by ten cribs that accepted liquid wastes containing low levels of radioactivity, and by a series of diversion boxes that routed high-level waste to underground tanks. The diversion boxes and high-level waste piping sometimes leaked. In addition, most of the PUREX cribs became saturated over time, and were replaced by other cribs. Planned, untreated liquid discharges to the ground at Hanford ceased in 1995.

Initial planned PUREX discharges to ground averaged 6.5-million gallons per day, and reached as high as approximately 20-million gallons per day by the peak of Hanford's production in the early 1960s. The massive volume of the discharges caused mounds to develop in groundwater under the PUREX cribs and ponds. The mounds in turn skewed the natural hydraulic gradient, and caused groundwater to move in unexpected directions and pathways. Understanding the contaminants still "hung up" in the substrata of the 200-MW-1 OU, as well as those already in groundwater, is essential to making decisions about remediation.

"The A-4 borehole represented the first significant and high-risk drilling into the area just south of the PUREX Plant and west of the PUREX tunnels," says Austin. "We need to understand the soil contamination as well as we can, because remediation can be expensive and will have long-lived consequences. The best possible decisions need to be made by consensus of everyone concerned."

The A-4 borehole was drilled 10 feet southwest of the crib to avoid exposing workers to soils with dangerous levels of contamination and extended approximately 315 feet. Fluor Hanford workers took hundreds of "grab" samples of soil as well as five "split spoon" samples which are larger and more sophisticated. In 2007, the borehole was converted to a groundwater-extraction well.

The unlined A-4 crib received waste from the PUREX laboratory, along with condensates from the huge PUREX ventilation fans and the "ammonia scrubber" system that trapped ammonia to prevent it from venting to the atmosphere. Drainage from the PUREX exhaust stack and canyon cells, and liquid waste generated by decontaminating equipment in the canyon, were also disposed to the crib. However, perhaps the most contaminated waste was drainage from the 241-A-151 diversion box, which may have allowed Cs-137 and Sr-90 and some Pu, Am-241, and Tc-99 to reach the A-4 crib.

Since the A-4 crib borehole was drilled, sampled and converted, Fluor has drilled three additional boreholes in the area just south of PUREX, investigating the A-2, A-21 and A-30 cribs. All of the boreholes are yielding specific information about how contamination has migrated from Hanford's most prolific chemical-separation plant. In addition, the samples are helping to correlate actual subsurface contamination with geophysical characterization of the area from 2006, when Fluor Hanford mapped the 200-MW-1 underground area with electrical-resistivity scanning.

Building on the 200 West Area model, Fluor is using data collected from the groundwater as it is studying soil in Hanford's 200 East Area. During 2007, Fluor delivered draft work plans to DOE for two massive groundwater OUs stretching across the 200 East Area. The 200-BP-5 and 200-PO-1 OUs also extend north, south and east of the 200 East Area, spreading across more than 160 square miles –about 27 percent of the entire Hanford Site.

The 200-PO-1 OU covers groundwater under roughly the southern half of the 200 East Area, including the groundwater under the PUREX Plant and its many cribs, trenches and other liquid-disposal sites. The OU also includes groundwater stretching east and intersecting the Columbia River. At approximately 130 square miles, it is the largest in terms of land surface area at the vast desert site.

Important contaminants of concern include tritium, I-129, Sr-90, nitrates, Tc-99 and U, all emanating from PUREX. Fluor is now studying the 200-PO-1 OU in two phases. Phase I, being done this year, does not include drilling any new wells, but collates and reviews existing information, and collects geophysical soil data. Seismic and airborne electromagnetic data are being gathered to identify subsurface geological layers, channels, faults and anomalies, to look at how the soil contributes to further release of contaminants. Fluor is also placing 10 new aquifer tubes at the rivershore borders of the OU. Aquifer tubes are small, shallow, flexible sampling devices used to determine levels of contamination just as groundwater reaches the river.

Phase II, scheduled for FY2009, will summarize the information gathered in Phase I, and then determine if and where new wells are needed. In the meantime, samples from the boreholes south of PUREX will be analyzed and correlated.

In the northern half of the 200 East Area, the 200-BP-5 OU stretches beneath the region and north and northwest to the Columbia River. At approximately 32.6 square miles of surface area, this OU encompasses a soil column approximately 240 feet deep. DOE, Fluor and regulators all realize that soil contaminants can affect the groundwater. It's important to understand whether (or how rapidly) soil contaminants can be expected to move and perhaps intersect with plumes beneath the 200-PO-1 OU, possibly reaching the Columbia.

In April 1945, B-Plant began separating plutonium from irradiated uranium fuel, to extract the weapons material needed to win World War II. It is the second-oldest radiochemical separations plant in the world. Its chemistry employed liberal amounts of sodium bismuthate and phosphoric acid to purify plutonium. These chemicals, made radioactive by their contact with the irradiated fuel, were disposed to single-shell tanks (some of which later leaked) and soils, trenches, drains and other waste disposal sites near the plants. Thus, the soil and groundwater of the 200-BP-5 operable unit are contaminated with these chemical and radioactive constituents. Major contaminants of concern in the 200-BP-5 OU are U and Tc-99, along with tritium, nitrates, and I-129. Cyanide, Sr-90, Cs-137 and Pu also have been detected.

The 40 single-shelled tanks near B-Plant received other highly contaminated waste over the years until approximately 1980. In addition, 23 cribs, reverse wells (wells used for some early waste disposals), and trenches exist near B-Plant's tanks. Another 29 trenches, cribs, reverse wells and ponds overlay the 200-BP-5 OU.

From 1952-55, the BX and BY cribs and trenches received more than 9 million gallons of waste from U-Plant's Metal Recovery Mission. From 1951-1974, operation of the 242-B Evaporator and an in-tank solidification program in the "B" Tank Farms discharged more than 40 million gallons of condensate from tank wastes to the "B" cribs. Beginning in 1949, C-Plant discharged its highly contaminated waste to the C Tank Farm, and several cribs, trenches and the 216-C-9 pond overlying the 200-BP-5 OU. In total, more than 300 million gallons of waste were discharged to soils in the "Semi-Works [C-Plant] and Waste Management Area C" of the 200-BP-5 OU. Another major program to retrieve Sr-90 and Cs-137 constituents from tank waste, conducted in B Plant from 1968-1982, disposed more than an additional 200 million gallons.

When combined with unplanned releases and spills, the total amounts of liquid wastes discharged to the waste sites overlying the 200-BP-5 operable unit created mounds in the groundwater under it. The mounds were similar to, and often interacted with, those created by PUREX. The most significant mounds occurred under B Pond and Gable Pond, where mounds peaked in the late 1960s, and the 1980s, respectively, at approximately 20 feet above pre-Hanford Site levels.

Today, the mounds have nearly disappeared, reducing the flow toward the north and west. However, more investigation is needed. Fluor Hanford last year completed three new wells near the northwest corner of the 200 East Area, and is now planning several hydraulic tracer tests and pump tests to monitor the flow of groundwater at several points within the 200-BP-5 OU. This year, SGRP is also drilling 12 additional wells, pushing more boreholes, and collecting soil and groundwater samples.

Fluor Hanford is also part of a multi-contractor B Complex Integrated Project Team formed in 2006 to investigate the B-Plant tanks, cribs and trenches area. The team includes Fluor Hanford, CHG, PNNL, DOE and regulatory agencies. Presently, Fluor Hanford and CHG are conducting electrical-resistivity surveys in the region.

The electrical resistivity tests of the soil are "helping to determine the extent to which soil contamination is contributing to the ongoing transport of contaminants to the groundwater," said Austin. "That's the key question here in 200-BP-5, and it may be a crucial question to many of the other operable units. We've got to understand transport – how fast are contaminants migrating in the soil, to what degree is there lateral migration, and what is the composition of the contaminant solution – before we can begin to think of remedial options."

Conclusion

Options for remediating the soil in Hanford's Central Plateau range from taking no action to removing, treating and disposing it. Along the continuum of solutions, alternatives such as partial removal or "surgical removal" of "hot spots," treatment and disposal, monitored natural attenuation (reduction), *in-situ* treatment, institutional controls, and engineered barriers will also be considered. The Tri-Parties and interested stakeholders are watching Fluor's investigations carefully, and heatedly debating potential remedies.

"Because the issues are so complex, final RODs have not been reached on any of the Central Plateau waste sites yet," said Austin. "There are limited resources, and everyone is considering the best way to expend them. When you're dealing with a 250-300-foot-deep vadose zone, you need to be very clear and very careful before you make a decision."

Photos and Captions for "Final Frontier" Article
Radwaste Solutions, May/June 2008
Michele Gerber

1. Site Map "Hanford Areas at the 586-square mile site sit at widely varied depths above the groundwater table. The soil column in the Central Plateau, encompassing an imaginary ellipse around the 200 East and West Areas, is approximately 250-300 feet deep.

2. B Plant 1945 "One of Hanford's earliest radiochemical separations facilities – B Plant – new in 1945."

3. U Plant aerial.best.98070285-80cn "Fluor Hanford has written and gained approval for the first-ever Record of Decision to dispose of a Hanford radiochemical separations plant – U-Plant."

4. Gable Pond "Gable Pond, Hanford's largest receptacle for low-level liquid wastes, as it appeared in the 1960s. Liquids disposed to the pond percolated through Site soils."

5. U Pond Graphic "Schematic view of Hanford's U Pond, showing location of new direct-pushes, test pits and borehole that Fluor is using to further characterize soils beneath the pond."

6. Burial Box.35585-13 1-64 "Solid waste is disposed in a burial box in a trench in central Hanford, 1964."

7. Pipeline near PFP.3.1954 "This 1950s pipeline is located outside of Hanford's Plutonium Finishing Plant and is part of more than 100 miles of contaminated inactive pipelines being investigated by the Soil and Groundwater Remediation Project."

8. BC Cribs.looking north.1956 "The BC Cribs and Trenches as they appeared in central Hanford in 1956. Fluor Hanford is currently digging into selected portions of the cribs to investigate soil contamination."

9. 06050006-105df "Fluor Hanford workers carefully capture a contaminated soil sample removed from the Z-9 slant borehole, 2006."

10. Z9 Rig. 1 "A unique slanted borehole was drilled under Fluor Hanford supervision to characterize contaminated crib soil, 2006."

11. ZP Treatment Building.outside.base of stripper "Treatment facility in Hanford's 200 West Area that has thus far removed more than 24,000 pounds of carbon tetrachloride from groundwater."

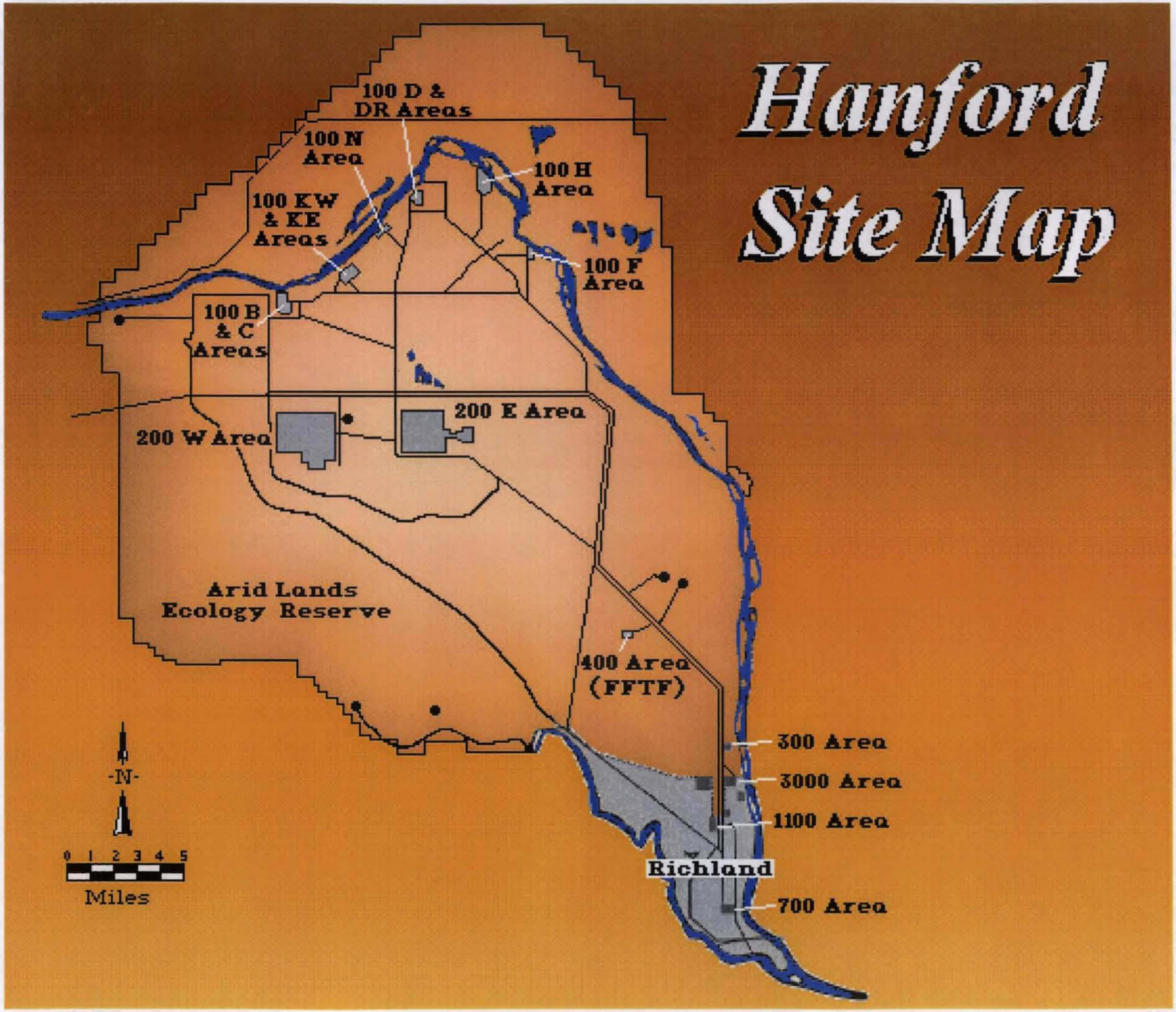
12. PUREX crib A8.new.1955 "A-8 crib used to dispose low-level liquid wastes to soil is shown new in 1955, with the massive PUREX Plant above and left. A Hanford coal-burning steam plant (with double stacks) appears in top center of photo.)

13. A4.showing whole scene "The PUREX Plant looms behind deep borehole drilling site, 2006."

14. A4 workers with drill string.5 "Fluor Hanford workers drilling deep borehole into contaminated soil, 200 East Area, 2006."

15. Split Spoon "Fluor Hanford worker carefully captures contaminated soil sample in containment enclosure, 2007."

16. BY Drill.3.07.3 "Drilling a well near B-Plant in Hanford's 200 East Area, as part of integrated soil and groundwater study efforts, 2007."


Hanford Site Map
100 D & DR Areas
100 N Area
100 H Area
100 KW & KE Areas
100 F Area
100 B & C Areas
200 E Area
200 W Area
Arid Lands Ecology Reserve
400 Area (FFTF)
300 Area
3000 Area
1100 Area
Richland
700 Area
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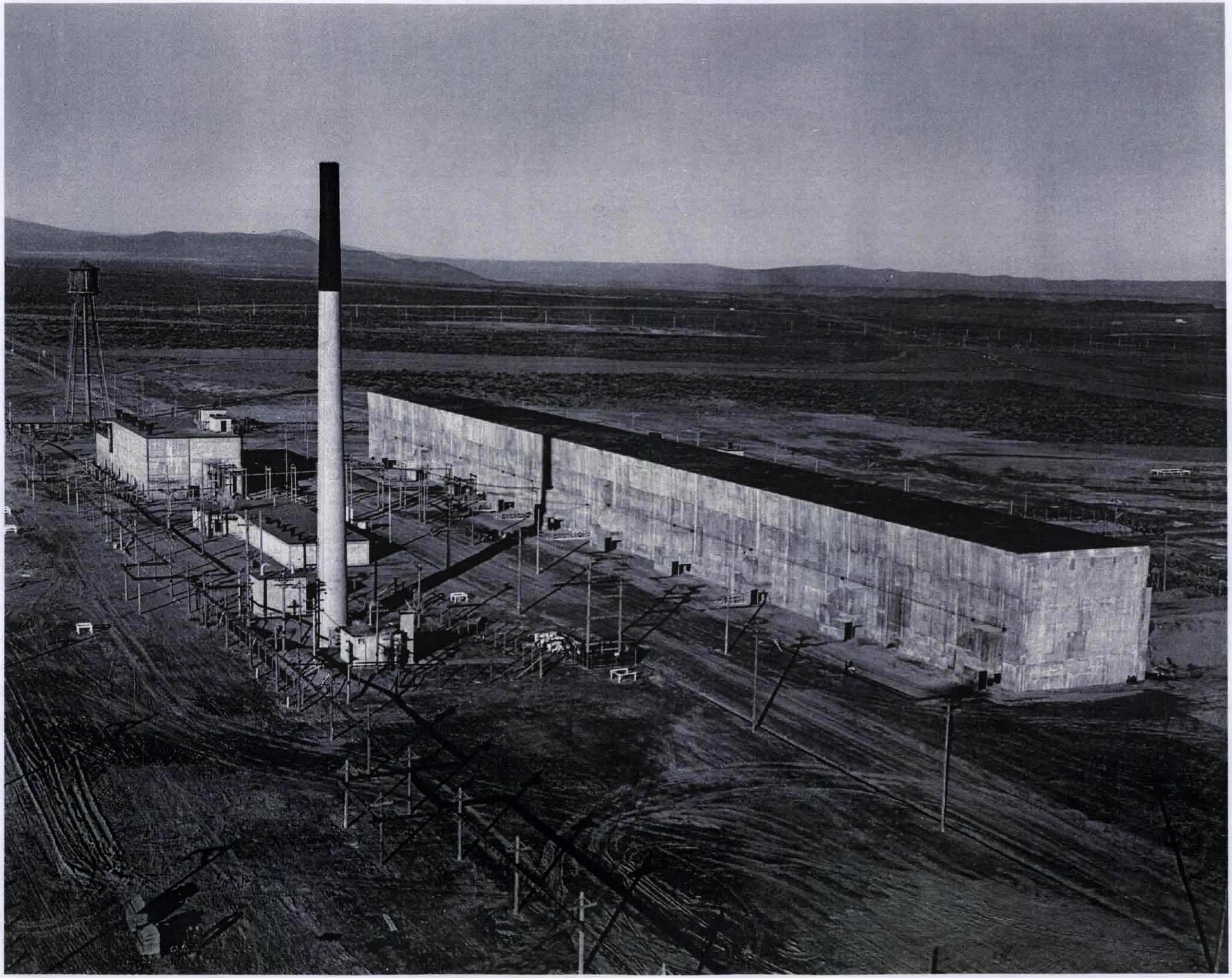
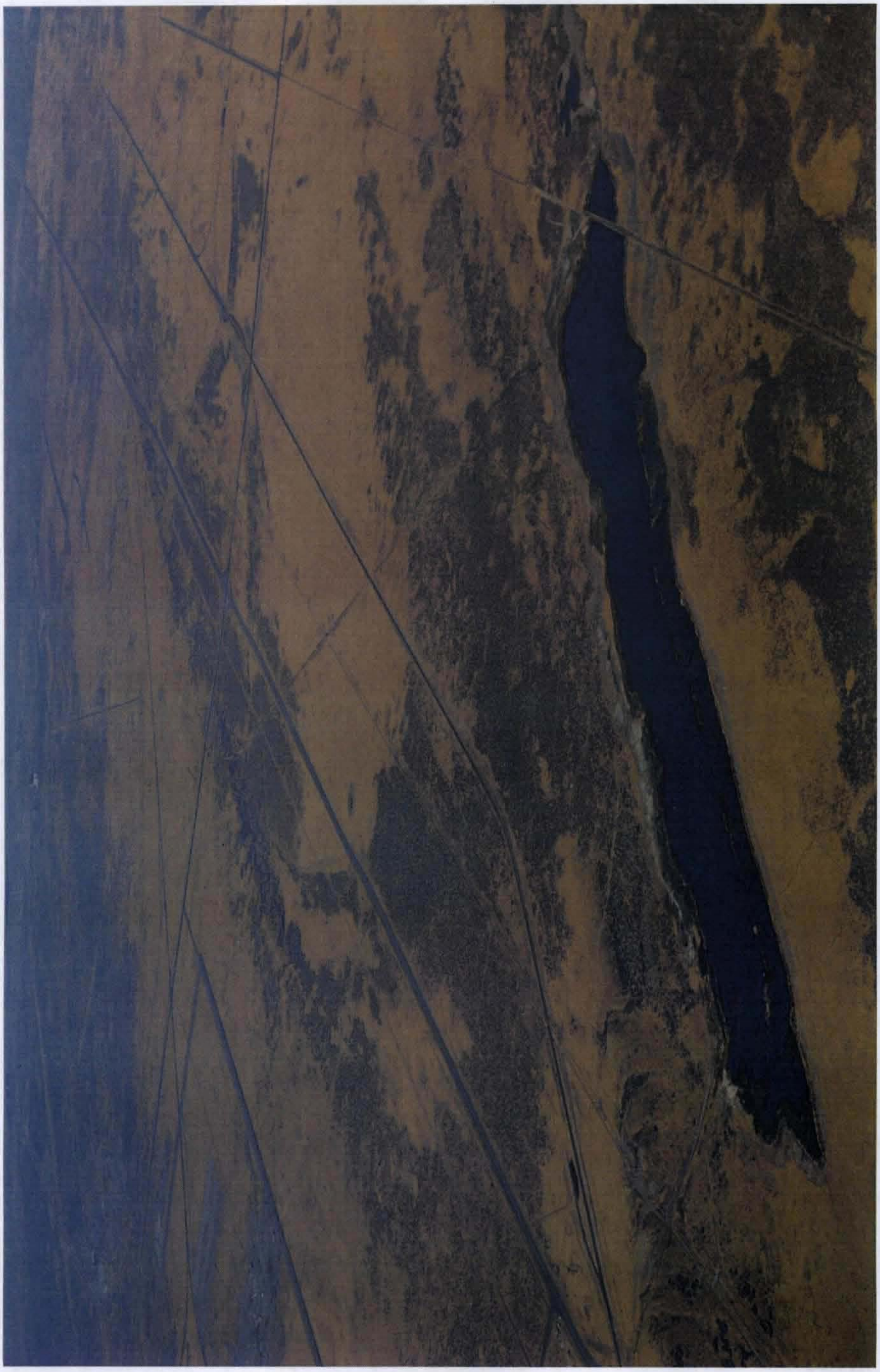
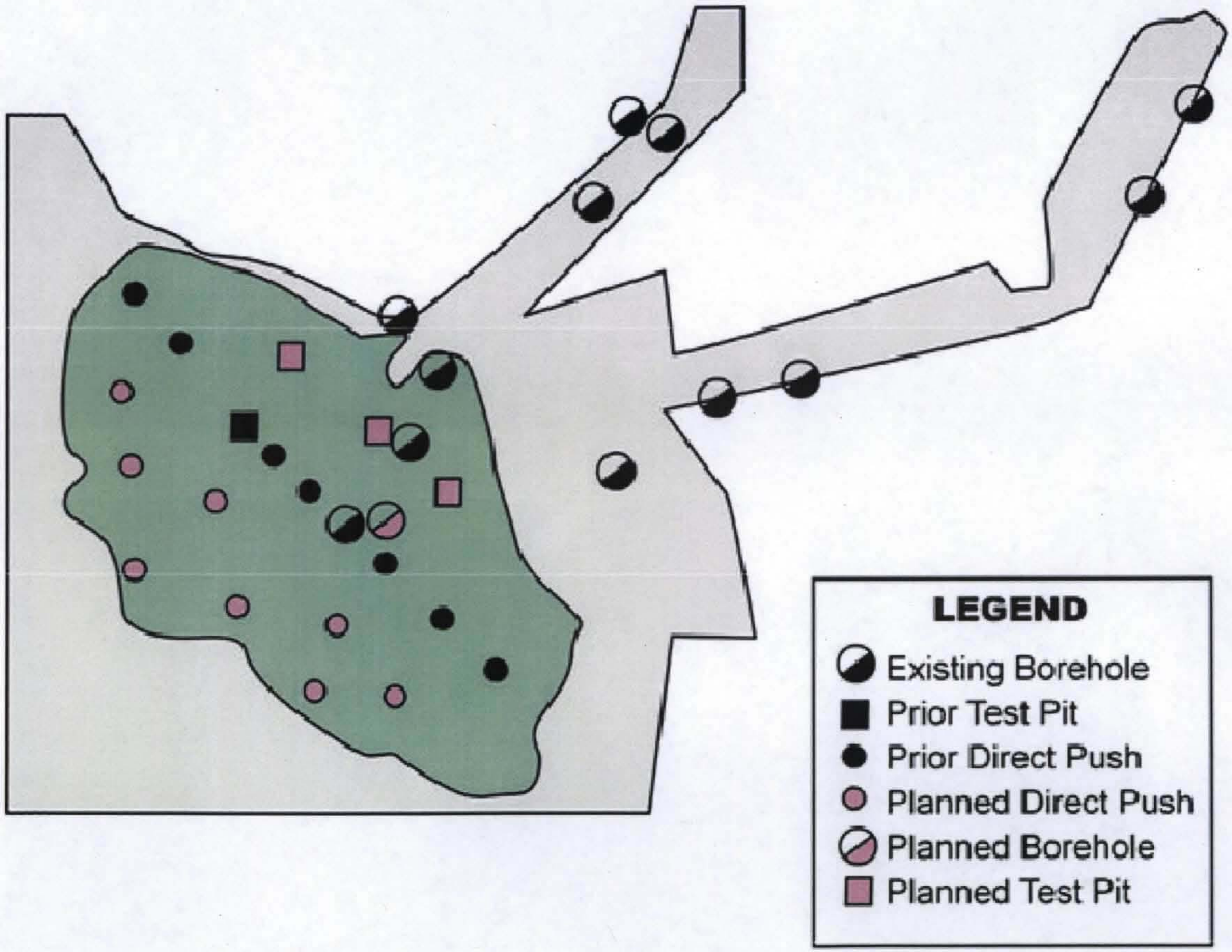
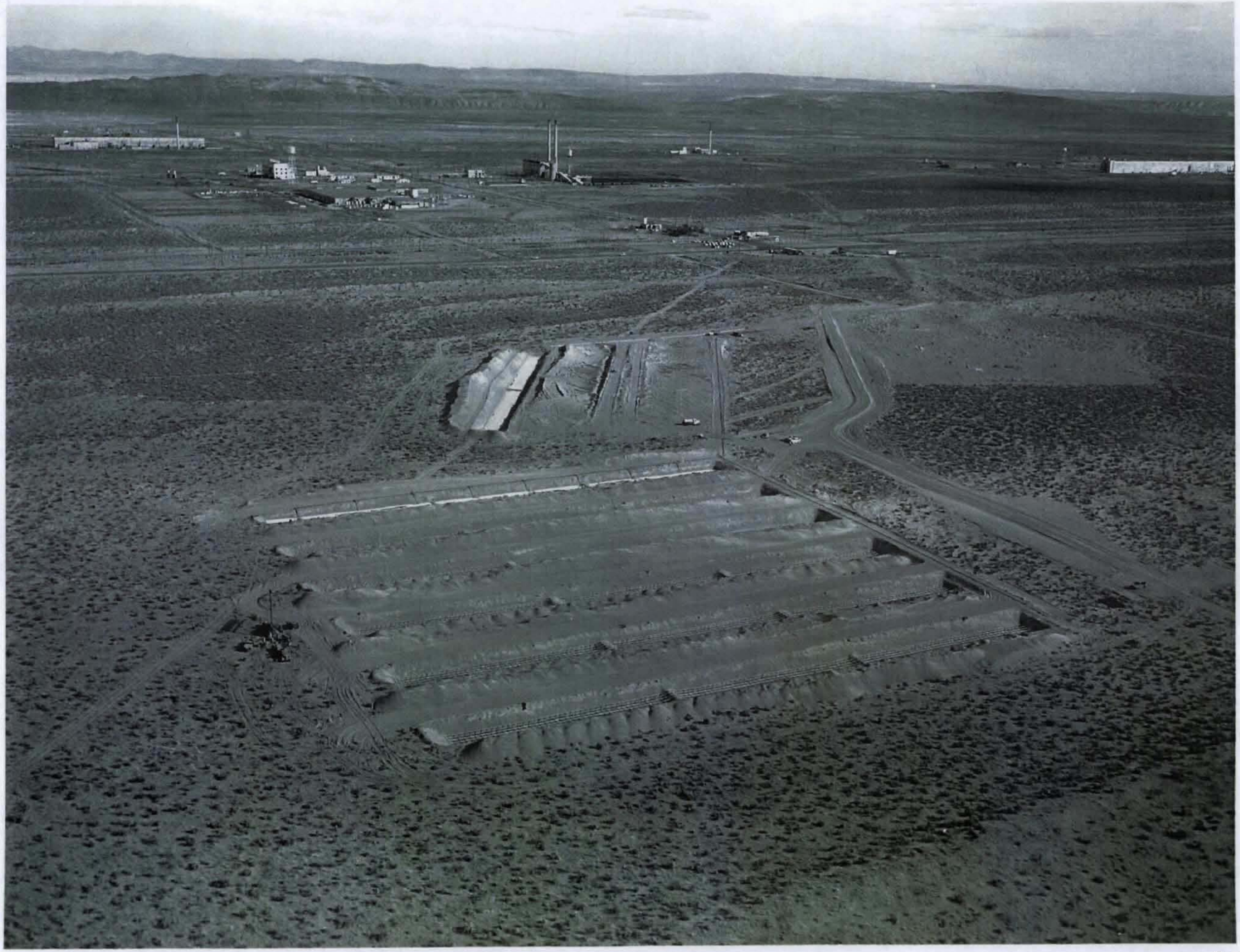





LEGEND
Existing Borehole
Prior Test Pit
Prior Direct Push
Planned Direct Push
Planned Borehole
Planned Test Pit

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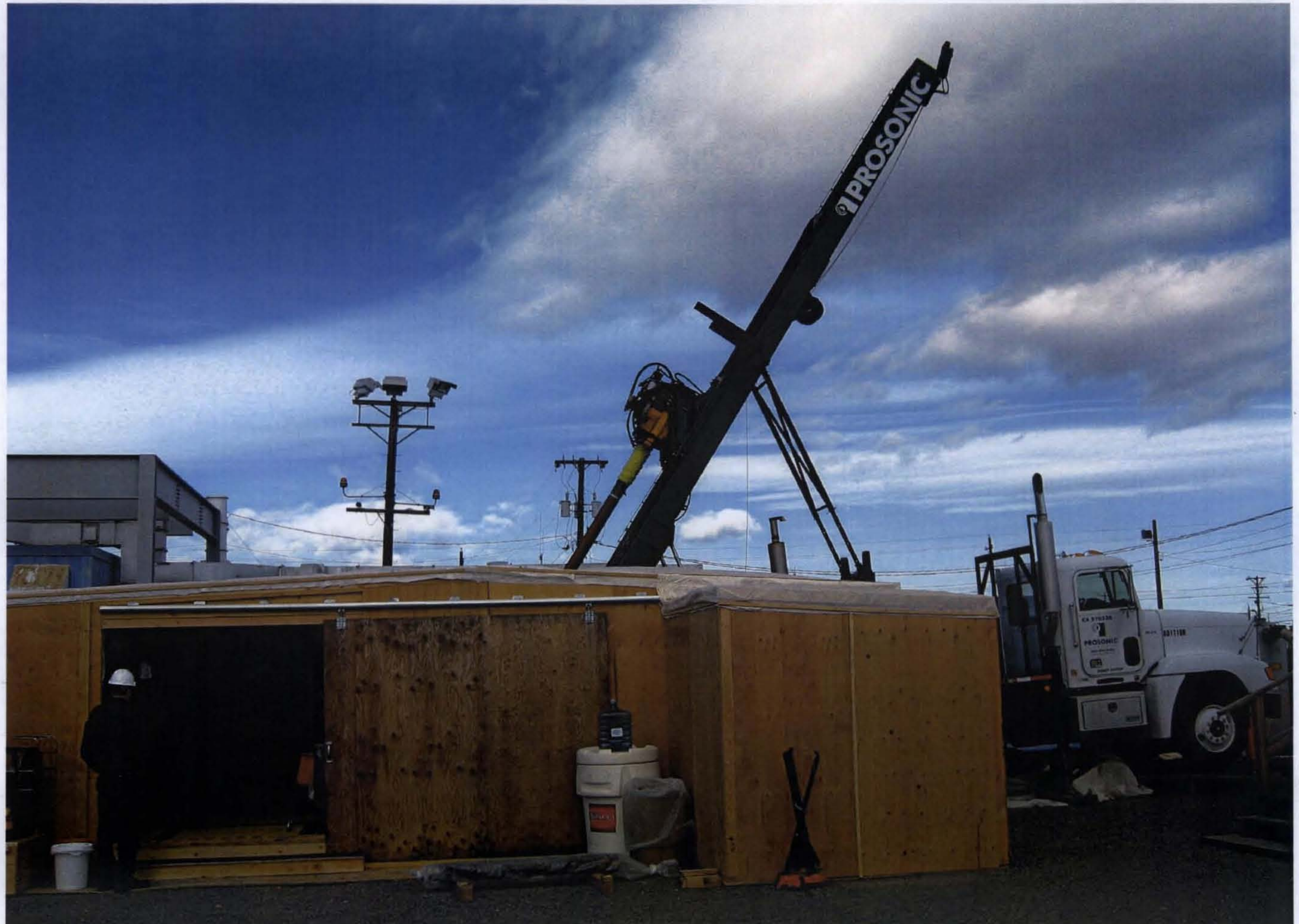
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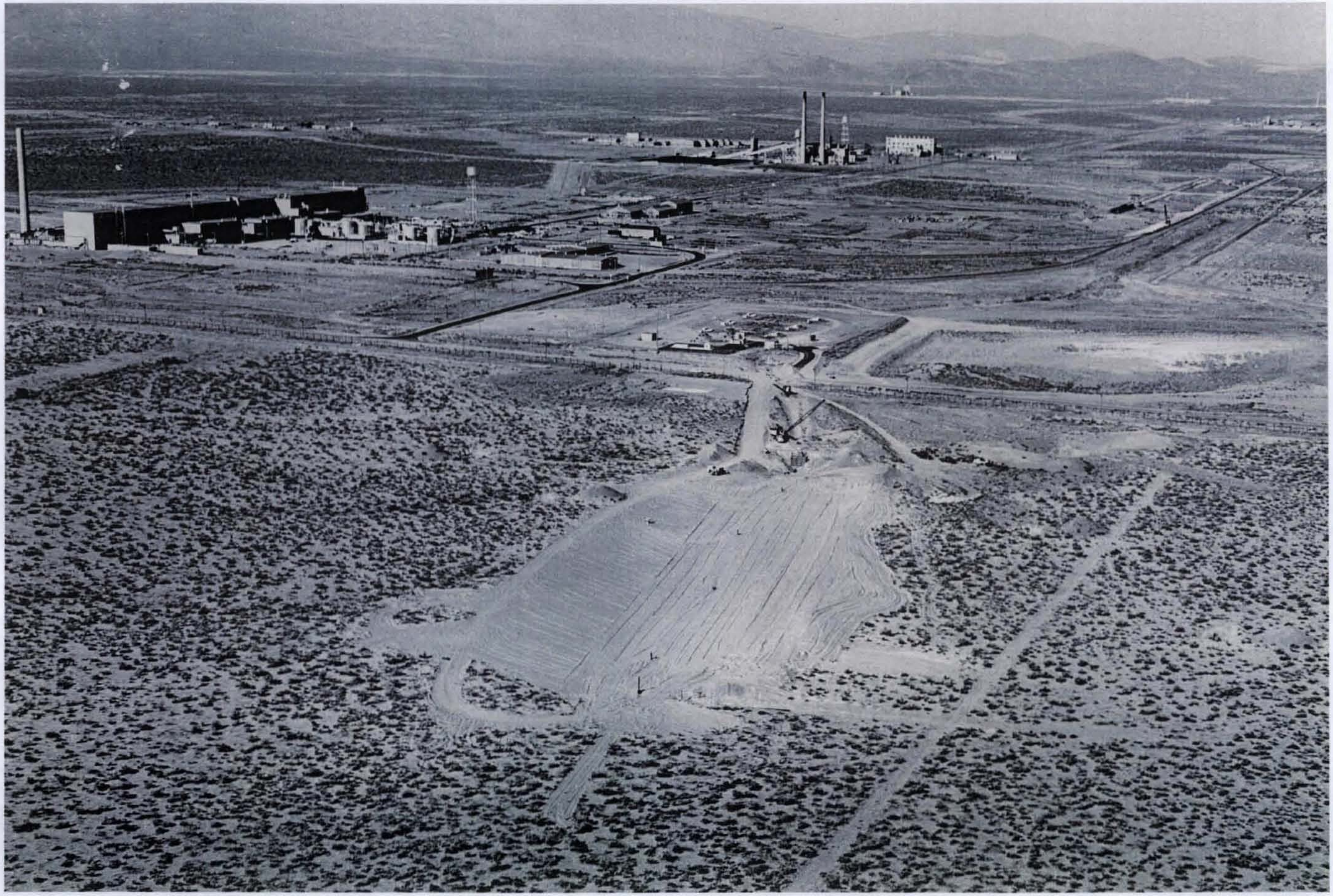

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HUGHES


CAUTION


BLUE STAR
ENTERPRISES
NORTH WEST
72-SPEED STAR